

REMARKS

Claims 1-5 are currently pending in the present application.

Claim 1 has been amended to clarify that titanium is incorporated during the crystallization of *the crystalline titanosilicate catalyst*. The amendment of claim 1 made herein is solely to clarify what was already implied in the prior version of the claim. Claim 1, as amended, is no narrower than the previous version. Claim 5 has been added to particularly point out and distinctly claim a preferred embodiment of Applicants' invention. Support for the amendment to claim 1 can be found in the Specification, for example, at Paragraph [0014]. Support for new claim 5 can be found in the Specification, for example, at Paragraph [0015]. The amendments presented herein introduce no new matter and necessitate no additional claims fees. A complete listing of all claims ever presented in accordance with 37 C.F.R. §1.121(c)(1) is set forth herein. Accordingly, entry of the amendments is proper and respectfully requested.

In the Office Action, the Examiner rejects claims 1-4 under 35 U.S.C. §112, second paragraph, as being indefinite. Specifically, the Examiner contends that the term "MWW structure" is unclear as the structure is not "set forth in the Specification or the claims" and that it cannot be ascertained how the claimed structure is different from other titanosilicate catalysts. Additionally, the Examiner contends that claim 4 is indefinite because it is not clear what is reacted with propylene to produce hydrogen peroxide. Applicants respectfully traverse the Examiner's indefiniteness rejection and the arguments and contentions set forth thereof for the following reasons.

With respect to the rejection of claim 4, Applicants submit that the synthesis of hydrogen peroxide recited in the claim is clear and not indefinite. Claim 4 is directed to a method of claim 1, "wherein hydrogen peroxide used in the reaction is synthesized within the reaction of propylene." (See, claim 4). Based at least in part on the disclosure set forth in Paragraphs [0023] & [0024] of the Specification, one of ordinary skill in the art would understand that claim 4 is directed to embodiments of Applicants' claimed invention, wherein the hydrogen peroxide used in the reaction is produced *in situ* via any suitable system for the *in*

situ production of hydrogen peroxide, such as, for example, the reaction of hydrogen and oxygen in the presence of a transition metal catalyst as described in Paragraph [0023]. It is respectfully submitted that claim 4 is clear to those of ordinary skill in the art. Accordingly, Applicants submit that claim 4 is definite and complies with the requirements of §112, second paragraph.

With respect to the Examiner's indefiniteness rejection based upon the use of the phrase "MWW structure", Applicants respectfully submit that the term is understood by those of ordinary skill in the art and that the claims are not indefinite, by use of the term. As set forth in Applicants' Specification, for example, at Paragraphs [0004] & [0005], and in prior art cited by the Examiner (*e.g.*, U.S. Patent No. 6,141,551 of Levin, *et al.* (hereinafter referred to as "Levin"), and Wu, P. and Tatsumi, T., "Extremely high trans selectivity of Ti-MWW in epoxidation of alkenes with hydrogen peroxide," Chemical Communications, pages 897-898 (2001), (hereinafter referred to as "the Wu article"), the term "MWW structure" is recognized by those of ordinary skill in the art of zeolite catalysts as referring to zeolite structures having a diversity of supercages, *e.g.*, 10-membered rings in channel formations, along with 12-membered ring side pockets, which structures are often referred to as MCM-22 zeolites.

Applicants respectfully submit that the term MWW structure is in no way unclear and fully complies with the requirements of 35 U.S.C. §112, second paragraph. The Examiner has contended that the language of the claims is unclear because it fails to indicate how the structure is different from prior art titanosilicate catalysts for reacting propylene. Applicants respectfully disagree. As set forth in claim 1, the catalyst has an MWW structure containing titanium, wherein the titanium has been incorporated during crystallization of the titanosilicate catalyst. This process for forming an MWW titanium-containing catalyst is different than that of Levin. Levin teaches the introduction of titanium via a process referred to as atom-planting. In atom-planting, titanium is introduced after de-alumination by "the impregnation of a dealuminated MCM-22 catalyst precursor with titanium tetrachloride by physical contact of the catalyst precursor and the titanium compound." (*See*, Levin, col. 1, lines 54-57). In other words, the dealuminated MCM-22 crystalline catalyst is physically contacted with TiCl₄. Any titanium is added to the already crystallized MCM-22 catalyst.

The titanosilicate MWW catalyst of the present invention is prepared by the incorporation of titanium during the crystallization of the titanosilicate catalyst. The incorporation of titanium during the crystallization of the titanosilicate MWW catalyst of the present invention enables the introduction of titanium into the framework of the pore of the catalyst, thereby providing an MWW structure containing both framework titanium and titanium present in the pore of the supercage structure. (*See*, Applicants' Specification, Paragraph [0014]).

It is respectfully submitted that the catalyst of the present invention prepared via the incorporation of titanium during the crystallization of the titanosilicate MWW catalyst is different than the catalyst prepared according to the process of Levin and this difference is clear from the claim language. The use of the phrase "MWW structure" is not unclear. In Levin, titanium tetrachloride (TiCl_4) is contacted with the catalyst subsequent to crystallization of the catalyst. Applicants would like to draw the Examiner's attention to the enclosed article published in ZEOLITE NEWS LETTERS, Vol. 20 (4), at pages 147-155, (2003) by Wu and Tatsumi (authors of the Wu article relied upon by the Examiner in the Office Action), which was published on December 10, 2003. As set forth in the attached partial translation of a pertinent portion of the reference

"... Ti-MCM-22 thus prepared does not show so high activity in cyclohexene oxidation than expected. Because the molecular size of TiCl_4 ($6.7 \times 6.7 \text{ \AA}$) is bigger than the size of the pore entrance of the 10-membered oxygen ring ($4.0 \times 5.5 \text{ \AA}$), and its introduction into the pore and insertion into the framework defect is strictly restricted, uniform introduction of the metal [titanium] ion into the framework appears to be difficult."

(*See*, ZEOLITE NEWS LETTERS, Vol. 20 (4), p. 151, right-hand column, lines 6-16, enclosed partial translation).

Thus, Wu and Tatsumi clearly recognize in their 2003 publication that the physical contact of titanium tetrachloride with an MWW catalyst structure does not result in the

incorporation of titanium into both the framework and pores of the catalyst structure. While the ZEOLITE NEWS LETTERS article is **not** prior art in the instant application (as its publication date is subsequent to the International Filing Date of the instant application), Applicants have submitted herewith a Form PTO-1449 listing the ZEOLITE NEWS LETTERS article for the Examiner's convenience, in the event the Examiner wishes to make the article of record in the instant application.

Based on the foregoing explanation of the well-known term "MWW structure" and the clear distinction of the present invention over prior known MWW structures based upon the process used to produce the catalysts, Applicants respectfully submit that the claim language is clear and not indefinite. Accordingly, reconsideration and withdrawal of the Examiner's rejection under 35 U.S.C. §112, second paragraph, are respectfully requested.

In the Office Action, the Examiner rejects claims 1-4 under 35 U.S.C. §103(a), as being unpatentable over Levin in view of the Wu article. Specifically, the Examiner contends that Levin discloses the epoxidation of propylene with hydrogen peroxide in a solvent, using a crystalline titanosilicate catalyst. The Examiner acknowledges that Levin fails to teach or suggest the specific crystalline titanosilicate catalysts having an MWW structure, wherein the titanium is incorporated into the catalyst during the crystallization of the titanosilicate catalyst. However, the Examiner contends that the Wu article teaches the epoxidation of hexene using hydrogen peroxide in a nitrile solvent, in the presence of a crystalline titanosilicate catalyst with MWW topology. The Examiner argues that one ordinary skill in the art would have been motivated to use the catalyst disclosed by Wu in the process of Levin for epoxidation of propylene because "Wu teaches unique selectivity in the epoxidation of a mixture of cis-trans isomers using [the disclosed] Ti-MWW catalyst." (*See*, the Office Action, page 3). Applicants strenuously, but respectfully, traverse the Examiner's rejection and the arguments and contentions in support for the following reasons.

First, Applicants respectfully submit that the cited combination of Levin and the Wu article does not contain the requisite teaching or suggestion which would provide one of ordinary skill in the art with the motivation to combine and modify the teachings of the

references, as suggested by the Examiner, in order to arrive at Applicants' claimed invention. Nothing in either reference would motivate the use of the Wu catalyst in the process of Levin. Second, Applicants submit that the combination of references does not provide one of ordinary skill in the art with a reasonable expectation of successfully epoxidizing propylene via the Levin process with the catalyst of Wu. Finally, even if it were assumed for argument's sake that the cited combination establishes a *prima facie* case of obviousness, which it does not, Applicants respectfully submit that any such *prima facie* case of obviousness is sufficiently rebutted by the evidence of surprising and unexpected advantages achieved through Applicants' claimed invention, as evidenced by the Declaration of Hiroaki Abekawa under 37 C.F.R. §1.132 submitted herewith.

To begin with, Applicants' claimed invention is directed to methods for producing propylene oxide, wherein the methods comprise reacting propylene with hydrogen peroxide in the presence of an organic solvent and a crystalline titanosilicate catalyst, the catalyst having an MWW structure containing titanium, wherein the titanium has been incorporated during crystallization of the titanosilicate catalyst. As set forth above, the catalysts of the present invention, which have titanium incorporated into the pores of the catalyst supercage structure, are different than those set forth in Levin. the Examiner has acknowledged that the catalysts of Applicants' invention are different than those disclosed in Levin.

The Wu article is directed to the use of certain catalysts for the selective epoxidation of trans hexene isomers, wherein the stated goal is reactive-selectivity between trans- and cis-isomers of hexene. Wu is not concerned with the epoxidation of propylene or any other olefin which does not have cis and trans-isomers.

Catalysis is an unpredictable field. Wu is directed to reactions of hexene with the objective of selectively reacting one isomer (trans-) over another (cis-). Levin is directed to the reaction of propylene, with no concern as to isomer selectivity as propylene does not have such isomeric forms. The Examiner has not advanced a justifiable rationale to support the assertion that one of ordinary skill in the art would expect one zeolite catalyst disclosed as being useful for selectively reacting trans-hexene apart from cis-hexene, to be successful for reactions of

propylene. There is no teaching or suggestion in the Wu article to apply its teachings to any other reaction scheme.

Accordingly, Applicants respectfully submit that the Examiner has failed to establish a *prima facie* case of obviousness based upon the combination of Levin and the Wu article as the cited combination fails to provide one of ordinary skill in the art with the requisite motivation to combine and modify the prior art teachings in order to arrive at Applicants' claimed invention, and further fails to provide one of ordinary skill in the art with a reasonable expectation of success, especially in light of the uncertainty of catalysis.

Even assuming, for argument's sake, that a *prima facie* case of obviousness could be established based upon the combination of Levin and the Wu article, which it cannot, Applicants respectfully submit that any such *prima facie* case of obviousness is sufficiently overcome by the evidence of significant and unexpected advantages achieved by Applicants' claimed invention. In support thereof, Applicants submit the Declaration of inventor Hiroaki Abekawa under 37 C.F.R. §1.132.

As set forth in the attached Declaration of Mr. Abekawa, it can be seen that the catalyst activity and propylene oxide selectivity of a titanium-containing MWW catalyst of the present invention is significantly and surprisingly higher than a dealuminated MCM-22 catalyst treated with titanium tetrachloride. More specifically, as set forth in Table 1 of the Abekawa Declaration at page 5 thereof, the catalyst activity of a titanium MWW catalyst in accordance with one embodiment of the present invention is 0.463 moles propylene oxide, per hour, per gram of catalyst. In contrast, the catalyst activity of a dealuminated MCM-22 catalyst contacted with titanium tetrachloride is a mere 0.00045 moles propylene oxide, per hour, per gram of catalyst.

Additionally, as set forth in Table 1, the propylene oxide selectivity for the catalyst of the present invention is strikingly higher than the prior art catalysts for epoxidizing propylene. The catalyst of the present invention has a PO selectivity value of approximately

99.9%, whereas the prior art dealuminated MCM-22 catalyst treated with titanium tetrachloride has a significantly lower PO selectivity value of 5.1%.

Applicants respectfully submit that the comparative evidence set forth in the Abekawa Declaration clearly evidences the superiority of Applicants' claimed invention with respect to the production of propylene oxide via the reaction of propylene and hydrogen peroxide. Accordingly, it is submitted that any *prima facie* case of obviousness which has allegedly been established based upon the cited combination of Levin and the Wu article, is sufficiently rebutted by the evidence set forth in the Declaration. Accordingly, reconsideration and withdrawal of the rejection under 35 U.S.C. §103(a) are respectfully requested.

In view of the Remarks set forth above, as supported by the comparative data set forth in the Abekawa Declaration, it is respectfully submitted that all claims comply with the requirements of 35 U.S.C. §112, second paragraph, and patentably distinguish over the prior art of record and known to Applicants. Accordingly, reconsideration, withdrawal of all rejections and a Notice of Allowance are respectfully requested.

Respectfully submitted,

Hiroaki Abekawa, *et al.*

May 4, 2006
(Date)

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Enclosures: Form PTO-1449 with reference and partial translation
Petition for Extension of Time (three months)
Declaration of Hiroaki Abekawa under 37 C.F.R. §1.132